Iron stress and sucrose availability perturb genetic phloem differentiation programs

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Plant cell differentiation generally occurs via a stereotypical program that is perturbed by environmental stress. Iron deficiency is an environmental stress that reduces plants' ability to synthesize chlorophyll and photosynthesize sugars that plants need to be productive and properly develop their tissue and organ systems. Phloem is tissue within the plant vasculature network that transports photosynthetic sugars, signals, and nutrients, such as iron, between organs. In the model plant *Arabidopsis thaliana*, phloem is a model for understanding cell differentiation because it completely differentiates within a vertical region of approximately 20-25 cells dividing up the root from an undifferentiated "stem" cell in the root tip, producing a gradient of cells representing distinct phases of differentiation, from initial phloem precursors to functional, specialized phloem cells. Thus, we aimed to capture how phloem differentiation is both generally regulated and perturbed by iron stress. After analyzing differentially extracted genes expressed in FACS-sorted developmentally distinct phloem cells from either control or iron deficient roots, we developed Gene Regulatory Networks (GRN) which describes the relationships between genes interacting to regulate phloem differentiation under either unstressed or iron deficient conditions. We examined mutants and overexpressors of several genes identified as master regulators of each network for a relationship to iron deficiency and/or phloem development. Then, we aimed to understand whether root sucrose availability also affected root phloem development. One gene, in particular, COGWHEEL 1 (COG1) is a master regulator in the +Fe GRN and the -Fe GRN. Strangely enough, *cog1* seedlings appear to be chlorotic and have reduced root growth even in both iron deficient and iron sufficient conditions, but growth is recovered only in excess sucrose and sufficient iron conditions. Also, *cog1* sieve elements mature earlier within the root under iron sufficient conditions. Here, we will discuss possible explanations for these phenomena, which suggest links from iron and sucrose signals to the genetic regulation of phloem differentiation.